



**PROPOSE NEW FRAMEWORK FOR NETWORK
PERFORMANCE TESTING STRATEGY**

MOHD KAMAL TARMIZI BIN RAZAK

**MASTER OF COMPUTER SCIENCE
(INTERNETWORKING TECHNOLOGY)**

2017



Faculty of Information and Communication Technology

PROPOSE NEW FRAMEWORK FOR NETWORK PERFORMANCE

TESTING STRATEGY

Mohd Kamal Tarmizi Bin Razak

Master of Computer Science (Internetworking Technology)

2017

**PROPOSE NEW FRAMEWORK FOR NETWORK PERFORMANCE
TESTING STRATEGY**

MOHD KAMAL TARMIZI BIN RAZAK

**A dissertation submitted
in fulfillment of the requirements for the degree of Master of Science
in Computer Science**

Faculty of Information and Communication Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

DECLARATION

I declare that this dissertation entitled “Propose New Framework for Network Performance Testing Strategy” is the result of my own research except as cited in the references. The dissertation has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this dissertation and in my opinion this dissertation is sufficient in term of scope and quality for the award of Master of Computer Science (Internetworking).

Signature :

Supervisor Name :

Date :

DEDICATION

I lovingly dedicate my dissertation to my beloved wife Zuraini Binti Zainal who supported me each me step way. To my precious sons and daughter, Affi Hazeem, Aqil Hadeef and Arissa Mea Humaira who give me passion and strength with their smile. You are “ Anugerah Allah yang Terindah”

ABSTRACT

Performance evaluation is one of the main concerns in the communication system. In any communication implementation, to determine the performance factor of the network, a testing of end-to-end connection process flow is required. An effective and coordinated testing procedure plays an important role in evaluating the performance of the network. Therefore, this study proposes a testing framework which specifies the types of communication mediums and technologies, the evaluation criteria and tools to carry out the testing. The proposed testing scheme is used as a guideline to analyze and measure the performance of the real time network.

ABSTRAK

Dalam sistem komunikasi, penilaian prestasi merupakan sesuatu yang perlu diberikan perhatian. Di dalam mana-mana pelaksanaan sistem komunikasi, bagi menentukan faktor prestasi rangkaian, ujian aliran sambungan akhir-ke-hujung perlu dilaksanakan. Keberkesanan prosedur ujian secara teratur memainkan peranan yang penting dalam menilai prestasi sesuatu rangkaian. Oleh yang demikian, kajian ini mencadangkan satu rangka kerja ujian yang menentukan jenis medium komunikasi dan teknologi, faktor penilaian dan peralatan yang akan digunakan bagi menjalankan ujian tersebut. Skim ujian yang dicadangkan akan digunakan sebagai panduan untuk mengukur dan menganalisis prestasi rangkaian dalam masa sebenar.

ACKNOWLEDGEMENTS

In the name of Allah, Most gracious, Most Merciful. All praises belongs to Allah. First of all, I would like to thank to Allah Al the Mighty, who made me capable to complete the dissertation throughout those difficult years.

First and foremost, I would like to thank to my supervisor, Associate Professor Dr Faizal Bin Abdolah for his excellent supervision, guidance, supporting and encouragement towards in completing my dissertation. May Allah reward him with a reply that much better than what all he has done.

I am in debt and owe great thanks to my beloved wife (Zuraini Binti Zainal), dearest sons and daughter (Affi Hazeem, Aqil Hadeef and Arissan Mea Humaira) for their patience, inspiration, continuous encouragement and thoughtful advice throughout my years as a Master student.

I would like to extend my thanks to my colleagues, all Staff FTMK, UTeM for their time, guidance and kind support during my study. Last but not least, my special thanks to all my friends for their time, understanding, advice and continues moral support.

TABLE OF CONTENTS

| | PAGE |
|---|-------------|
| DECLARATION | |
| APPROVAL | |
| DEDICATION | |
| ABSTRACT | i |
| ABSTRAK | ii |
| ACKNOWLEDGEMENTS | iii |
| TABLE OF CONTENTS | iv |
| LIST OF TABLES | vii |
| LIST OF FIGURES | viii |
| LIST OF APPENDICES | x |
| LIST OF ABBREVIATIONS | xi |
| | |
| CHAPTER | |
| 1. INTRODUCTION | 1 |
| 1.1 Project Background | 2 |
| 1.2 Problem Statement | 3 |
| 1.3 Research Question | 3 |
| 1.4 Objective | 4 |
| 1.5 Research Scope | 4 |
| 1.6 General Research Methodology | 5 |
| 1.7 Project Significant | 6 |
| 1.8 Expected Result | 6 |
| 1.9 Summary | 6 |
| | |
| 2. LITERATURE REVIEWS | 7 |
| 2.1 Introduction | 8 |
| 2.2 Computer Network | 8 |
| 2.3 Performance of a Network | 10 |
| 2.4 Internet Protocol - IPv4 and IPv6 | 12 |
| 2.4.1 IPv4 | 13 |
| 2.4.2 IPv6 | 15 |
| 2.4.3 IPv4 and IPv6 Comparison | 15 |
| 2.5 A Layered Structure | 17 |
| 2.5.1 Open System Interconnection (OSI) Reference Model | 18 |
| 2.5.1.1 The Physical Layer | 18 |
| 2.5.1.2 The Data Link Layer | 19 |
| 2.5.1.3 The Network Layer | 19 |
| 2.5.1.4 The Transport Layer | 20 |
| 2.5.1.5 The Session Layer | 20 |
| 2.5.1.6 The Presentation Layer | 21 |
| 2.5.1.7 The Application Layer | 21 |
| 2.5.2 TCP Reference Model | 21 |
| 2.5.2.1 The Link Layer | 22 |
| 2.5.2.2 The Internet Layer | 22 |
| 2.5.2.3 The Transport Layer | 22 |
| 2.5.2.4 The Application Layer | 23 |

| | | |
|-----------|---|-----------|
| 2.5.3 | OSI and TCP Reference Model Comparison | 24 |
| 2.6 | The UDP Protocol | 28 |
| 2.7 | The TCP Protocol | 30 |
| 2.8 | TCP Connection Establishment and Release | 33 |
| 2.9 | Congestion Control | 35 |
| 2.10 | Performance of Network | 35 |
| 2.11 | Network Performance Parameter | 37 |
| 2.11.1 | Network Delay | 38 |
| 2.11.2 | Packetization Delay | 38 |
| 2.11.3 | Queuing Delay | 39 |
| 2.11.4 | Propagation Delay | 40 |
| 2.11.5 | Transmission Delay | 40 |
| 2.11.6 | Processing Delay | 41 |
| 2.11.7 | Packet Loss | 41 |
| 2.11.8 | Throughput | 42 |
| 2.12 | Analysis of Current Problem | 42 |
| 2.13 | Summary | 43 |
| 3. | RESEARCH METHODOLOGY | 45 |
| 3.1 | Introduction | 45 |
| 3.2 | Project Methodolog | 46 |
| 3.3 | Exploratory Study | 46 |
| 3.4 | Quantitative Technique | 47 |
| 3.5 | Case Study | 47 |
| 3.6 | Scenario | 47 |
| 3.7 | Data Collection | 47 |
| 3.8 | Data Analysis | 48 |
| 3.9 | Interpret Finding | 48 |
| 3.10 | Propose Framework | 48 |
| 3.11 | Documentation | 48 |
| 3.12 | Proposed Framework | 48 |
| 3.12.1 | Determine The Best Test Tools to use | 50 |
| 3.12.2 | Define Test Parameters | 50 |
| 3.12.3 | Define The Performance Strategy | 50 |
| 3.12.4 | Design Test Scenario | 51 |
| 3.12.5 | Execute Performance Tests | 51 |
| 3.12.6 | Analyze The Result and Prepare Results Report | 51 |
| 3.12.7 | Summary | 51 |
| 4. | IMPLEMENTATION | 52 |
| 4.1 | Introduction | 52 |
| 4.2 | Hardware Specification | 52 |
| 4.2.1 | Fluke Optiview XG | 54 |
| 4.2.2 | Fluke LinkRunner AT 2000 | 54 |
| 4.2.3 | Fluke DTX-1800 Cable Analyzer | 54 |
| 4.3 | Network Configuration | 55 |
| 4.4 | LAN Acceptance Test | 56 |
| 4.5 | Network Performance Test | 57 |
| 4.6 | Packet Payload Sizes | 58 |

| | | |
|-----------|---|-----------|
| 4.7 | Network Infrastructures Test | 58 |
| 4.8 | Summary | 59 |
| 5. | RESULT AND ANALYSIS | 60 |
| 5.1 | Introduction | 60 |
| 5.2 | LAN Media Testing Result for Acceptance Test | 61 |
| 5.3 | Performance Testing Result | 61 |
| 5.3.1 | Result for laboratory Segment | 62 |
| 5.3.1.1 | Artificial Intelligence Lab 4 Results | 62 |
| 5.3.1.2 | Assistant Engineer Room | 64 |
| 5.3.1.3 | Fiber Optic Lab Results | 66 |
| 5.3.1.4 | Multimedia Lab 4 Results | 68 |
| 5.3.2 | Result for Management Office Segment | 70 |
| 5.3.2.1 | Management Office 2 nd Floor Results | 70 |
| 5.3.2.2 | Management Office 1 st Floor Results | 72 |
| 5.4 | Infrastructures Testing Results | 74 |
| 5.4.1 | Path Analysis | 74 |
| 5.4.2 | Network Design Mapping | 75 |
| 5.5 | Summary | 76 |
| 6. | CONCLUSION AND FUTURE WORK | 77 |
| 6.1 | Introduction | 77 |
| 6.2 | Summary of Research | 77 |
| 6.3 | Summary of Contribution | 78 |
| 6.4 | Limitation of Research | 79 |
| 6.5 | Future Work | 80 |
| 6.6 | Conclusion | 80 |
| | REFERENCES | 81 |
| | APPENDIX | 88 |

LIST OF TABLES

| TABLE | TITLE | PAGE |
|--------------|---|-------------|
| 2.1 | Research Paper Summary | 42 |
| 2.2 | Summary of Proposed Framework | 43 |
| 3.1 | Network Test Strategy | 50 |
| 4.1 | Hardware Specification | 53 |
| 4.2 | Network Performance Strategies Process Flow | 57 |
| 4.3 | IMIX Genome Packet Sizes | 58 |
| 5.1 | Testing Configuration | 60 |
| 5.2 | Performance Test Result | 62 |
| 5.3 | Path Analysis Result | 74 |
| 5.4 | Bottleneck Result | 75 |

LIST OF FIGURES

| FIGURE | TITLE | PAGE |
|---------------|--|-------------|
| 1.1 | General Research Methodology | 5 |
| 2.1 | Literature Review Plan | 7 |
| 2.2 | Comparison of IPv4 and IPv6 Headers Structures | 16 |
| 2.3 | Different Network Models and Their Corresponding Layer | 24 |
| 2.4 | Different applications for both TCP and UDP | 27 |
| 2.5 | UDP Packet Structure | 29 |
| 2.6 | Reliable and unreliable data transfer structure | 30 |
| 2.7 | TCP Packet Structure | 32 |
| 2.8 | Three way handshake for connection establishment and termination | 35 |
| 3.1 | General Project Methodology | 46 |
| 3.2 | Propose Strategy Framework | 49 |
| 4.1 | Network Design Of Test Environment | 55 |
| 4.2 | Acceptance test report | 56 |
| 5.1 | Summary of cable testing | 61 |
| 5.2 | Throughput For Artificial Intelligence Lab 4 | 63 |
| 5.3 | Frame Loss Ratio For Artificial Intelligence Lab 4 | 63 |
| 5.4 | Latency Below Threshold For Artificial Intelligence Lab 4 | 64 |
| 5.5 | Throughput For Assistant Engineer Room | 65 |
| 5.6 | Frame Loss For Assistant Engineer Room | 65 |

| | | |
|------|---|----|
| 5.7 | Latency Below Threshold For Assistant Engineer Room | 66 |
| 5.8 | Throughput For Fiber Optic Lab | 67 |
| 5.9 | Frame Loss Ratio for Fiber Optic Lab | 67 |
| 5.10 | Latency Below Threshold For Fiber Optic Lab | 68 |
| 5.11 | Throughput For Multimedia Lab 4 | 68 |
| 5.12 | Frame Loss For Multimedia Lab 4 | 69 |
| 5.13 | Latency Below Threshold For Multimedia Lab 4 | 70 |
| 5.14 | Throughput For Management Office 2nd Floor | 71 |
| 5.15 | Frame Loss Ratio For Management Office 2nd Floor | 71 |
| 5.16 | Latency Below Threshold For Management Office 2 nd Floor | 72 |
| 5.17 | Throughput For Management Office 1 st Floor | 72 |
| 5.18 | Frame Loss Ratio For Management Office 1 st Floor | 73 |
| 5.19 | Latency Below Threshold For Management Office 1 st Floor | 73 |

LIST OF APPENDICES

| APPENDIX | TITLE | PAGE |
|-----------------|--|-------------|
| Appendix A | Performance testing result for Artificial Intelligence Lab 4 | 89 |
| Appendix B | Testing result summary | 100 |
| Appendix C | Bottleneck test result | 102 |

LIST OF ABBREVIATIONS

| | |
|---------|---|
| LAN | Local Area Network |
| CPU | Central Processing Unit |
| TTL | Time To Live |
| IP | Internet Protocol |
| IETF | Internet Engineering Task Force |
| QoS | Quality Of Service |
| OSI | Open System Interconnection |
| DoD | Department of Defence |
| TCP | Transmission Control Protocol |
| ARPANET | The Advanced Research Projects Agency Network |
| UDP | User Datagram Protocol |
| FTP | File Transfer Protocol |
| SMTP | Simple Mail Transfer Protocol |
| HTTP | The Hypertext Transfer Protocol |
| DNS | Domain Name System |
| ARP | Address Resolution Protocol |
| ICMP | The Internet Control Message Protocol |
| RTT | Round-Trip Time |
| UTeM | Universiti Teknikal Malaysia Melaka |
| FTMK | Fakulti Teknologi Maklumat dan Komunikasi |

| | |
|-------|--|
| SLA | Service Level Agreement |
| ITU-T | Telecommunication Standardization Sector |
| CIR | Committed Information Rate |

CHAPTER 1

INTRODUCTION

With the rapid growth of the Internet, it required the network development scale well. The network interconnection device has been widely used to support this changing. The switch, router and other network interconnection device have become an important part of the network. The performance of network interconnection device will directly influence the network size, network stability and reliability, so it is necessary to accurately evaluate it. A good network performance test system is helpful to ensure the computer network can be normal, safe, efficient, rational use and operation. The network performance test instrument has become essential to evaluating performance of various types of network and network acceptance.

Successful performance testing requires a good deal of time and experience. It is a common mistake to assume testing the performance of the network is a simple task that can be conducted by any technical person with the appropriate equipment in a few weeks' time. Performance testing requires a significant amount of forethought and diligence, as well as a high level of knowledge regarding the devices and protocols to be tested, and an intimate familiarity with the tools used to do the testing. It's easy to see how comprehensive and meaningful performance testing is largely relegated to a select group of experts, while many assume it should be no problem for any engineer to produce meaningful performance metrics after only a day or two of testing.

With that said, just about anyone can learn to conduct successful performance testing. The most important factor (by far), is time. Having enough time to properly design, implement, run, tune and evaluate the test methodology, environment, devices and results is the key to success in performance testing.

In addition to time, there is one other indispensable factor when evaluating performance: forethought. Forethought implies thorough goal analysis, planning and proactive problem solving. Forethought would be regarded as more essential than time, except that a failure to think ahead can, to a degree, be compensated for if you have enough time.

1.1 Project Background

The revolution in computer networking technology nowadays demands for high bandwidth, short response time, reliable network, guaranteed application services and optimum LAN traffic flow. With this revolution, the organizations require optimum network performance to maintenance their business operations and changing customer needs. Therefore, analysis of network performance is very important to maintain and improve network efficiency from time to time. One of the important test indicators of Network performance testing is described in RFC2544 (S. Bradner (Harvard University), 2013) .The specific test methods about network performance testing is described in RFC2544. Four key indicators is defined in RFC2544 it is throughput, latency, Frame Lost Rate, and Back-to-Back. These indicators are the basis for the evaluation of network devices and the basis for evaluate the Ethernet devices also the networks. However, the RFC2544 only describe the performance characteristics of a network interconnecting device but not describe the network testing strategy.

1.2 Problem Statement

Most network managers regularly find themselves working or involved with user complaints regarding with the network problem. These complaints concerns about poor access times, no access to resources or session failures. All network managers must determine the operational guidelines that their network services and users will find acceptable. These operational conditions can be considered normal for that network. Studies have shown that network managers are betting on increased bandwidth as the solution to network problems.

Studies that had been done show that, (Quang, See, Chee, Xuen, & Karuppiah, 2013) propose a performance testing framework to unify different testing method, (Karuppiah, 2013) propose a testing framework which specific the type of communication and (Dumitrescu, Raicu, Ripeanu, & Foster, 2004) also propose a distributed performance-testing framework designed to simplify and automate service performance evaluation. No testing strategy to performance the network performance analysis are defined.

A well-defined and properly implemented network testing strategy with correct parameter and network characteristics will help the network manager predict the operation of the network. With network testing strategy, the network testing can be measure and recording the network's state of operation over a period of time. It involves recording the current state of network operation to serve as a basis for comparison or control.

1.3 Research Question

1. When do we need network testing?

Comprehensive network testing will enable a network manager to maintain the network actively. This insight may allow the network manager to predict network operation under a given load, or anticipate problems created by new services.

2. What needs to be tested?

Some important network characteristics include delay/latency/jitter, throughput and packet drop. Each network should be evaluated individually. The network testing will then be developed around the relevant criteria for that network.

3. How to do it?

Requirement plan strategy to do the testing.

1.4 Objective

There are three objectives in this research:

1. To study network performance analysis framework and network performance parameters.
2. To propose new framework for performance testing strategy.
3. To test and evaluate the new testing strategy.

1.5 Research Scope

In order to achieve the Research Objectives, this research will focus on some issues as stated below:

1. To identify the classification of network performance parameters as a guideline to the proposed framework.
2. To evaluate the performance parameters for best-case scenario test parameters.
3. This new framework will be tested in Universiti Teknikal Malaysia Melaka at Faculty of Information and Communication Technology Network environment.

1.6 General Research Methodology

The research methodology has been developed in order to achieve the research objectives. The phases involved in this research methodology is illustrated in Figure 1.0 General Research Methodology.



Figure 1.1 : General Research Methodology

1.7 Project Significant

The main purpose of this project being conducted was to identify parameters for performance testing and strategy to deploy the test. At the end of the project, new network performance testing framework strategy is produced.

1.8 Expected Result

By the end of this project, the expected results have to be achieved by the stated objectives are:

- i. New framework for performance testing strategy are well define.
- ii. The best network performance parameters is identified.
- iii. To test and evaluate the new testing strategy

1.9 Summary

In conclusion, the problem statement, objective and scope are well defined and stated clearly in this chapter. Literature reviews on the activities contributed to the related work were conducted in the next chapter as well as the analysis of current problem and justification along with the proposed solution.